

The Pacific Northwest Aquatic Monitoring Partnership (PNAMP)  
Fish Population Monitoring Workgroup



Summary Report from the January 12, 2005

*Keith Wolf and Jennifer O'Neal co-chairs, Bob Bugert meeting facilitator*

*Monitoring and Evaluation Practitioners Workshop*

*Jointly sponsored by the PNAMP Fish Population Monitoring Work Group  
and the Upper Columbia Regional Technical Team*

*Executive Summary*

On January 12, 2005, a group of fifty resource managers, scientists, and monitoring field practitioners met in Wenatchee Washington to discuss monitoring efforts taking place in the Pacific Northwest. The workshop-style meeting was designed to initiate a regional discussion on “what’s working, and what’s not” with respect to field *implementation* of standardized approaches to monitoring and evaluation for aquatic populations.

Summarized elements from this workshop are provided in this report and are intended for those tasked with improving monitoring design, protocols, and methods, and importantly, for guiding efforts directed at improving communication and coordination between and among M&E practitioners and planners.

The consensus of the workshop group was that this meeting was useful and yielded valuable insights into how technical and policy monitoring issues are currently being managed. The group also indicated that annual (or semi-annual) meetings/symposia of this type would be beneficial. To this end, a feedback form has been distributed to the group soliciting input on what scope, venue and approach is best suited to continue the dialogue and work initiated at this workshop.

*Workshop Structure*

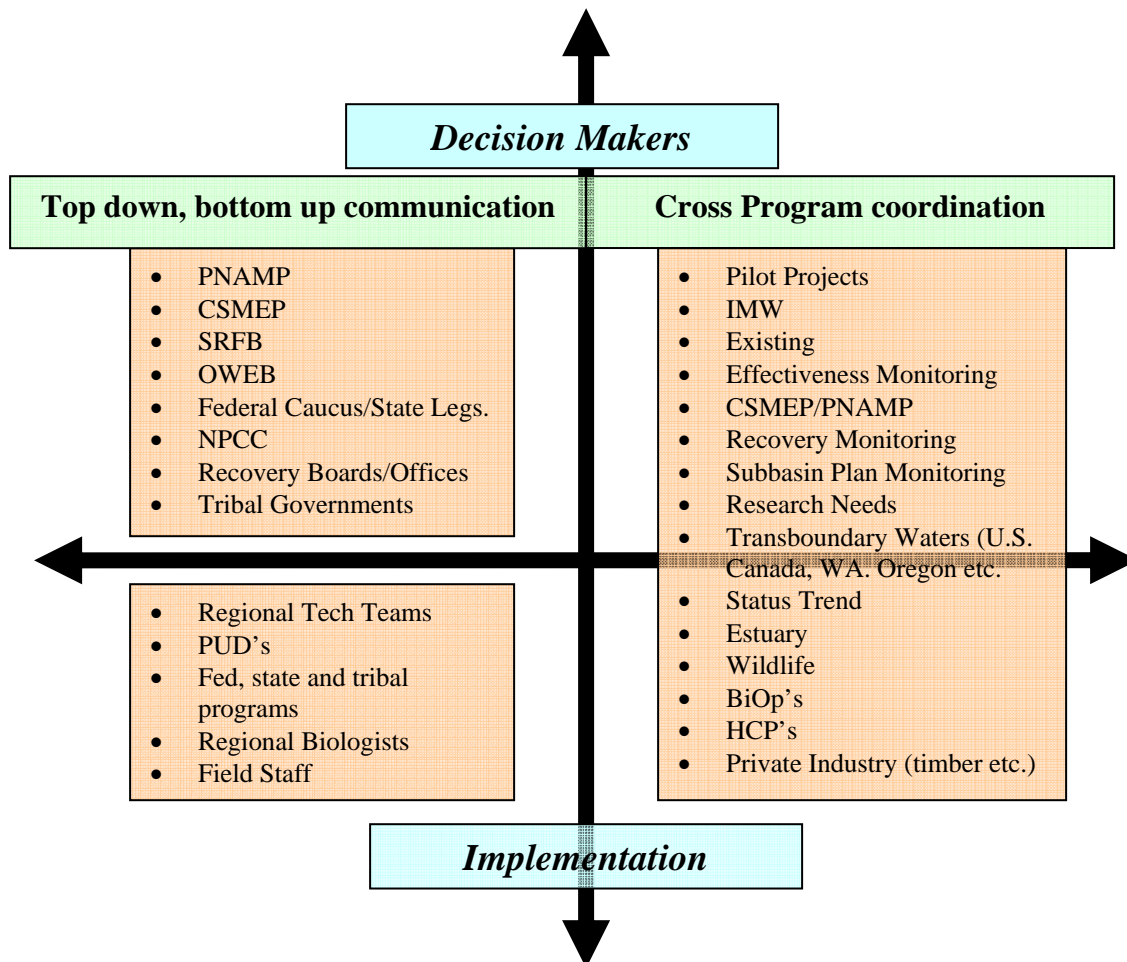
While it was the *Fish Population Workgroup* of PNAMP that sponsored this meeting (in conjunction with the Upper Columbia Regional Technical Team), technical issues (questions and challenges) spanning both biological and physical indicators, variables, analysis and design elements were discussed with a high level of information and idea sharing.

Generally, the group gravitated towards four themes/findings:

1. There is a need for improved communications pathways between and among M&E practitioners (cross-program and top-down, bottom up—see figure 1.),
2. Many technical issues remain unresolved. Sustained and detailed discussions aimed at solving persistent questions are necessary.
3. Broad input, participation and deliberation are required to reach a high level of understanding and consensus as new designs are proposed.
4. There are underexploited opportunities for promoting cost-effective implementation, data sharing and management and reporting to decision makers.

The workshop group included field staff at the implementation level, M&E developers at the design level, and decision-makers at the mid-policy level.

**Figure 1. Cross Program and Top Down, Bottom Up Coordination and Communication.** (bullets are example organizations and programs only). Goal of integrated decision-making is made more difficult and error bound without implementation of a model that *integrates* the coordination and information flow.



The specific goals of the workshop were:

1. Share retrospective information from the 2004 field season with an eye towards increased science rigor, efficiency and standardization of efforts and approaches.
2. Review on-the-ground implementation results and elicit input on how to improve coordination across regional monitoring efforts.
3. For the future: Inaugurate a recurrent process for cross-program coordination and multi-level M&E discussions (local levels and broader coordination processes).
4. Identify near and long-term coordination needs and devise an action strategy to address those needs.

This report intends to provide products for use by the participants, the PNAMP steering committee and others involved in development of M&E programs in the Pacific Northwest. This report contains:

- Final Agenda (attachment 1)
- Summary of Presentations
- Contact information for all attendees (attachment 2)
- Summary of technical issues and contemporaneous input
- Post workshop email comments/questions
- A feedback form for participants with results due in March 2005 (attachment 3)

## *Presentation Summary*

### **Dr. Tracy Hillman, BioAnalysts, Inc., Upper Columbia Monitoring Strategy**

Tracy Hillman presented about the Upper Columbia Monitoring Strategy. Many of the plan authors were present and provided input into the development of this regional strategy that encompasses the Upper Columbia ESU. Updates to this plan are envisioned as results from the Okanogan, Methow, Entiat and Wenatchee programs progress and specifically as the Upper Columbia Salmon and Steelhead Recovery Plan strives to identify “recovery” criteria.

The Upper Columbia Strategy addresses status and trends monitoring as well as effectiveness monitoring of selected projects in the region. The strategy incorporates a rotating panel design, with one panel of projects sampled every year and other panels sampled on rotating schedules. The site selection uses the EMAP based Generalized Random Tessellation Sampling (GRTS) with 100 percent over sample to allow for 50 percent of the sites not to be viable and still retain an adequate sample size.

Sites are selected to address two sampling universes – 1)Habitat and fish – includes the entire watershed stratified based on gradient; 2) Steelhead spawning universe does not sample in high gradient areas, but does sample above barriers.

The effort involves both classification of the areas in the basin by geomorphic and stream class as well as measurement of physical and biological elements across the basin. The classification element of the project is complete. Several physical and biological indicators are measured including several life stages (adults, redds, juveniles) of salmonids, macroinvertebrates, instream habitat parameters, and land use variables. Protocols for monitoring these indicators were selected from published documents that provided precise and accurate measurements were feasible, and affordable. One of the goals is to test for relationships among and between indicators in four ways 1) relationship among physical indicators, 2) relationships among biological indicators, 3) relationships between physical and biological indicators, and 4) relationships between classifications and physical and biological indicators.

Mike Ward of Terraqua Inc. is working on the report for the Wenatchee effort. Each agency involved may also produce a separate report.

Paul Wagner from KWA Ecological Sciences, Inc. asked specific questions about water quality testing in the strategy. In the Wenatchee, temperature is measured at the EMAP sites, but other continuous water quality measurements are taken at the mouths of the major waterways in the basin.

Bruce Crawford asked about targets in the basin to compare the data to. Tracy noted that some of the EMAP sites were in pristine areas of the basin and could serve as reference sites. Also, that the indicators he is using can be compared to the NOAA Properly Functioning Conditions ratings.

The data collected in the Strategy can be used as baseline for effectiveness monitoring work and data is available for pre-treatment information for other groups. Keith Wolf from KWA Ecological Sciences, Inc. identified as a goal to create a template Memorandum of Understanding for data sharing and publication rights to help facilitate a higher level of data and analysis sharing.

Andrew Murdoch of WDFW asked about teasing out the impacts of hatchery programs, especially with respect to recovery planning. Tracy suggested using marking and/or genetic testing to determine impacts. He noted that native stock in hatcheries are part of the recovery process and these effects would need to be separated from natural spawning to really determine the impacts.

This program allows specific research questions to be separated out and addressed by either the status and trends efforts or the effectiveness efforts. Chelan PUD, WDFW, USFWS, DOE, and the Yakima Nation are all monitoring in the Wenatchee Basin. These efforts require and would benefit from interagency coordination.

This strategy was originally set up as a five-year program, but funding may be extended until the data indicate the direction that should be taken for restoration efforts in the Wenatchee Basin.

There are currently three NOAA pilot projects: Wenatchee, Salmon River, and an estuary program. There is likely to be expansion to other areas and coordination of information would occur through PNAMP.

Keith also mentioned the data inventory process conducted by Dick O'Conner, Paul Wagner and Pete Hahn to catalogue metadata and make it available as a web-based tool through the CSMEP process and the PNAMP effort to catalogue monitoring efforts across the PNW.

### **Glenn Merritt – WA Department of Ecology, Wenatchee Basin Pilot Project**

This effort is the field test of the Upper Columbia Monitoring Strategy. It uses an EMAP site layout based on a reach length of 20 times bankfull width. Issues that came up during the monitoring are listed below:

- LWD Tally – size classes may not match across monitoring programs (e.g. USFS) (John A. mentioned that in the Okanogan the LWD size classes were based on break points along what other protocols are doing (e.g. 30 cm as a break point in both programs, and in EDT – allows data to be compared.)
- Pool Tally – Required pools to be at least as long as wide, with a max depth 1.5 times the crest depth. Shallow pools met these requirements, but it was questions as to whether they are biologically meaningful as pools.
- Off-channel Habitat – what is the cut-off size for counting?
- Habitat codes – different than those used in EMAP, four classes of fast/slow water.
- Invertebrates – need to establish a standard level of taxonomic ID. Check with the Xerces Society- Jeff Adams for standards. The targeted riffle approach with a kick net sample of 8 square feet was used. Gretchen Hayslip (EPA) also helps to coordinate invertebrate sampling across the region for the level of identification and metrics. There was discussion of the diagnostic uses of invertebrates and how they could be used to detect water quality or sediment problems. May be able to replace some of the other measurements at some point.
- Gradient – used a hand level for these measurements. Should bring two of these and a clinometer as a backup into the field.
- Dominant substrate – in bankfull width, part of the transect is bordering on terrestrial habitat which may not reflect channel conditions.
- Embeddedness – sand intermingled with moss was often misidentified. (sand vs. hardpan). Deep particles that were large presented problems for estimating embeddedness.
- Wetted width – make sure you are perpendicular to the stream.
- Flood prone width – needed for Rosgen classification. Not possible to measure on large rivers. Used map derived numbers on larger system.

- Canopy cover – Densiometer is what most are using. Some prefer Solar Pathfinder. Tough to standardize this measurement. Lots of discussion and definitions to try to calibrate these estimates.
- Bank stability – more instability noted above bankfull level
- Human disturbance – trails were classed as roads. May need to add a trails category.

Resampling was done at 10 % of the sites for QA/QC. Paul Wagner mentioned that QA/QC was a concern for many programs. What level of difference is cause for concern? What would be the corrective action? Sharing crew members between teams was mentioned as a helpful strategy.

### **John Arterburn (Colville Tribes Fish and Wildlife Department) and Paul Wagner (KWA)– Okanogan Basin Monitoring**

John discussed site selection and the rule the Okanogan team has applied to make the EPA site selection more focused. Rules are listed below:

1. No sites outside historic anadromous zone.
2. No sites above barriers that are likely to be in place for the next 10 years.
3. No sites with low (natural?) discharge (no 1<sup>st</sup> order streams)
4. No irrigation channels
5. No lakes in U.S. (Canadian sites in Okanogan will sample lakes).

Still need to evaluate sites in the field. May use EDT reaches for stratification in the future.

Okanogan has a field manual with data definitions, protocols and methods for crew training. Existing sources were used for these definitions and then refined in the field. John asked for feedback on the definitions from the group as far as whether they are clear or should be improved.

Indicator issues are identified below:

- Riparian Vegetation – subjective and very difficult to train staff. Also used riparian widths as a quantifiable measure of vegetation that was not as subjective. However, need to define riparian to accurately measure the width.
- Used EDT classifications for habitat codes as they were more detailed and could likely be rolled up. Had to develop definitions for these.

### **Bruce Crawford – Monitoring in Washington State**

Data pyramid shows the large number of field practitioners vs. the small number of executives making funding decisions on monitoring. Need accountability for spending if funding is going to continue.

Data collected on federal lands does not get into the State of the Salmon Report and would contribute to the overall picture. PNAMP is working on comparing the data dictionaries from the various programs and decide on names and definitions for a core set of variables. Two focus areas for these efforts 1) large scale status-trend information

(How are things in the region?) 2) Local management – where are the local problems and what needs to be fixed first? There are large costs for fine scale monitoring efforts.

Don't need the state to fund status and trend monitoring in areas where it is already being done ( Wenatchee, etc.)

VSP parameters may not all be addressed (genetics) but the other three are likely to be addressed by EMAP monitoring.

### **Greg Volkhardt – Intensively Monitored Watersheds**

One of the main questions for this effort is to address is fish production/productivity improving? Looking for population level changes from land management practices.

Three complexes identified for the effort (Strait of Juan de Fuca, Hood Canal, and Lower Columbia). Also Skagit and Wenatchee by different groups.

BACI on a watershed scale for small watersheds. Before/After for large watersheds. Project scale monitoring will also be done using a BACI design and will focus on lifestages believed to be affected by the project.

!0 total watersheds to be sampled. Flow, turbidity, and temp monitored at 10 locations. One climate station per complex. Monthly water quality monitoring. Reference points established at 100 m intervals over the anadromous zones; stratified by EDT or SSHIAP. These points allow for orientation on the stream and would include waypoints, photos, bankfull and wetted widths, substrate class, Montgomery-Buffington and Rosgen classifications, and channel confinement. Also notes would be made on any problems or restoration opportunities. Gradient was measured, but may switch to LIDAR for this (like in the Okanogan).

Riparian Assessment was done using methods from T. O'Neil as described in Johnson et al. 2003. (Habitat Relationships). Hankin and Reeves assessments were conducted basin wide to identify limiting factors. Planned for first year. Would only be repeated after major events.

Annual sampling using EMAP.

Fish abundance looking at eggs, parr, juveniles, smolts, and adults at the watershed scale. Adults are measured through weir counts, mark recapture, and redd count expansions from weekly spawner counts at high probability sites. Smolt to adult ratios are calculated and marine survival is expected to be the same for a given complex. Egg deposition is calculated from escapement x fecundity. Parr are collected during the summer using electrofishing at EMAP reaches. Fish are ad-clipped or tagged. Resampled as juveniles to get survival. Electrofishing was single pass with some three-pass for calibration. Would coordinate with USFWS in the Lower Columbia on electrofishing. Smolts monitored using variety of traps and wiers. Screw and scoop traps were shown to have different selectivities so both are used.

Number of sites per watershed reduced from 30 to 10 based on feasibility. Habitat unit element dropped from Hankin and Reeves as it will be picked up in EMAP. Continue with reference points and log jam monitoring.

### **R.D. Nelle – Bull Trout Monitoring**

Bull trout redd surveys discussed. Do Index sites represent the watershed? Do we need more frequent surveys for better redd ID in areas where more than one species are spawning? Redd surveys are more difficult for resident populations. Confidence ratings are given for bull trout redds. For “Probable” redds, these could be addressed by surveying the spawning areas before the fish come in to not hydraulic disturbance. Coordination would also help.

Bull trout telemetry was also done. May need to change antenna design as it was thought to be getting caught. Rotary screw trap on Entiat and Peshastin Creek – may not be able to detect peak in spawning run due to low numbers. Sub-adults not trapped well. Snorkel surveys are being used, but precision is uncertain in larger systems. May need to adjust protocol.

### **Discussion**

Work on the Payette NF has shown Wolman Counts to be very successful.

Main drivers for fish response are wood, pools, riparian vegetation and substrate. These are the hardest to get at with monitoring. These elements should be important parts of the protocol testing effort by Steve Lanigan.

Sample size – do we know if 50 sites is enough? Should be easy to tell if 50 is too many, but harder to tell if we need more. Power analyses should be able to tell us more. This could be done using existing data.

*Detailed Group Discussion Notes (use for review at future meetings and PNAMP general discussion on “topics.”*

#### **1. Specific Indicators that require clarification or standardization**

- LWD Tally and size classes
- Off channel habitat
- Criteria for pools
- Habitat codes
- Taxonomic levels for inverts
- Riparian veg (EMAP vs O’Neil)
- Dominant substrate and embeddedness rating
- Macroinvertebrates as indicators for substrate embeddedness
- Sensitivity issues for macroinvertebrates as indicators
- Percent fines as indicator of sedimentation and embeddedness



2. Definitions in EMAP not necessarily same as those in EDT. Most Columbia Basin using EDT as one analysis tool. Need to coordinate M&E to provide analysis tools/models with specific input or retool models to include current indicators.
3. Side by side comparison of embeddedness indicators, but need to identify which indicator is most appropriate for questions asked. Look for associations between embeddedness and fish compared with association between substrate composition and fish. Data are available in some streams to make these comparisons.
4. Need to simplify some indicators, particularly for embeddedness.
5. Easy to identify a few indicators for effectiveness monitoring—a little more challenging to address status/trend.
6. Identify priority indicators—OWEB and SRFB specific needs. Key is to identify the causal factor for decline and establish indicators that address those factors within a measurable reach or assessment unit. Tough when you got multiple factors.
7. Sensitivity analysis is required, but few indicators have sufficient data to detect changes.
8. Disturbances screw up status/trend monitoring—particularly eastside fires. Annual sampling addresses most of the indicators. Identification of correct scale in sampling.
9. The key indicators for status/trend (water quality, woody debris, substrate composition, riparian cover, and pools) are the most difficult to correctly measure.
10. Five years may be appropriate period to conduct power analysis and to isolate which indicators do the best job. Remote sensing may be used in near future to address spatial scale indicators, with side-by-side comparison to physical habitat measurements.
11. Need to identify the linkage of biotic factors to physical habitat indicators—poorly seeded habitats or reaches upstream of barriers. Perhaps other biotic factors indicators may be used for ecosystem health.
12. Suggest looking at some of the indicators to see if there are correlations among the data sets or if some appear independent. Should have sufficient data to being these autocorrelations.
13. AREMP using roads and vegetation as indicators in NW Forest Plan.
14. Sensitivity analyses for watershed condition indicators.

15. Some debate on whether to reduce the EMAP 50 site in rotating panel or to reduce the number of indicators in EMAP sampling sites.
16. Physical and Biological Variables for status, trend, effectiveness and/or recovery
17. Concern about capability of GRTS design to detect changes at the subbasin scale.
18. Identify leads for periodic practitioners review session.
19. Protocol builder? Use for all programs to establish common data definitions, forms etc. BOR—John Day developing.

*Notes from flip charts/wall*

- PARR PROB. (Variable)
  - Use smelt imp for mark/rer-p
  - Methods from IMW
  - (Permitting Issues)
  - Shock for pit
  - Timing
- Bull Trout
  - Index sites – compromise
  - (See RP bpt for list)

PROTOCOLS/METHODS

- Sample areas above passage barriers is key
- Embeddeness
- Many subjective at implementation
- Remote site sampling
- IS 50 sites/year
  - Correct? - Power analysis

PROTOCOL/METHODS

- BFW V. WW (X20, XYO)
- NW hydrography layer
  - (0\$) – National hl
- Crosswalk LWD
- Standardize
- XERCES.ORG
  - Sensitivity, etc.
  - (What's needed to assess)?
  - Index of health?

- & pres, disc. of results
- Decisions (who and why?)
- Gov, Congress
- Mid-level policy and tech levels need to interface
- PNAMP to Compare/contrast
- Defs. (UC?IAC?OK....)
- Coord. Efforts
- Entiat ex (IAC & OK)
- M & E for Recovery
- (VSP) under described and underdeveloped as guidance

#### COORDINATION

- Data availability?
- Hatchery effects?
- Effectiveness
- Standardize GIS proj./scale
- Match w EDT etc.
- Acceptable level of error

#### COORDINATION

- Landowner issues  
(outreach program?)
- Meshing Objectives
- Intra-agency
- Annual practitioners/field crew meeting  
(scale?) – Resource  
Sharing

#### COORDINATION

- What RME Question
- What analytical process  
(these condition design)
- Uniform approved to “score” (BC) for roll up
- CREW SHARING ACROSS SUBBASINS

#### CROSS & TOP/UP COORD. CONT.

- Email forum
- Link comms to levels ( BC. Ex.)
- Feedback form
- RMEG for B/T formed up on “recovery”, delisting  
(Status, trend??)

### CROSS-PROGRAM COMMUNICATION

- 2-day mtg. (split 2<sup>nd</sup> policy/tech)
- PA system
- Phone Bridge
- Regional v. local (need both)
- Peer-review process?
- Future meeting will/should incl. analysis of data

### PROTOCOLS/METHODS

- B/T: when is a redd a redd (Shepard/Graham)?
- Livestock!! Humans!
- Tagging problems
  - Broken antennae
  - Entangled
- Snorkel for B/T uses  
Peterson in larger systems applicable?
- BT DAY/NIGHT SNORKELING

### PROTOCOLS/METHODS

- GRTS (+) challenges (define universe  
Can use EDT reaches
- Broad enough to detect limiting factors
- Field Guide  
Dist. review...
- TRAINING & QA/QC  
Tools – video?

### INDICATORS/VARIABLES

- QA/QC w/replicates eval. Variability
- Clear set of defs. Eg; - Barrier
- Riparian width as surrogate for structure?  
Other attributes as correlates
- Finer scales as needed
- WQ networks problematic

### INDICATORS/VARIABLES

- Smolts for prod./FW
- M & E for recovery
- Dist. – Spawner abundance

### INDICATORS, VARIABLES.....

- Periphyton?
- Analysis – Relationships
- Glenn Mendel's List

## *Recommendations for Future Workshops (compiled)*

*Note: feedback forms being distributed to all participants ask for specific recommendations on this topic. Results from this survey will be available in March 2005.*

*Some general themes from contemporaneous feedback follow:*

1. Host specific issue workshops
2. Two-day meeting/workshop is required. First day general coordination and information sharing, second day = workgroup sessions on specifics (physical, biological protocols, data management, analytical approaches, goals.
3. DO THIS AGAIN! Continue to communicate with implementers and decision makers.
4. Host a single regional website for M&E resources and information sharing
5. Who is PNAMP? Who is CSMEP? What are they exactly, what are they supposed to do and how do implementers participate?
6. QA/QC process at the field, data and analysis levels need methods and rules
7. Resource Sharing and Multi-Agency Coordination needs to increase
8. Need Listing of resources and attendance list to establish top-down/bottom-up forum.
9. April symposium on broad-scale monitoring efforts for differing species and issues.
10. Establish/expand the PNAMP mailing list for work groups and protocol development and standardization.
11. Need for detailed field manual for sampling, protocols, and training.
12. Work is being done in 2005 by Rocky Mtn Station to identify what set of attributes the protocols are established for, precision and accuracy calibration. This could be available by 2006.
13. Structure annual meeting with sufficient time to have data and metadata available
14. More on the ground reviews (with data in hand) of problems and opportunities with field sampling techniques. Possible linkage with WDAFS for symposium on protocols and indicators.
15. Balancing the separate needs for smaller meeting of on the ground practitioners, with the top/down linkage.
16. First day is large scale coordination issues, followed by second day of local practitioners.
17. Include symposia/workshop to review analysis of status, trend and effectiveness data.

## *Post Workshop Email Questions/Comments*

Thoughts on Upper Columbia monitoring meeting, Jan. 12, 2005, Wenatchee, WA  
Dana Weigel, Bureau of Reclamation

During the meeting, biologists expressed frustration in being able to define habitat parameters and protocols, and the time and expense that describing habitat trends will cost (i.e. weighing numbers of samples vs the limited budgets). Tracy Hillman relayed a vision that the habitat monitoring would choose a few (4-5) variables that can be easily measured, monitored, and comparable across basins that would track a trend.

Thirty five years ago, the abundances of juvenile and adult salmonid populations were found to be well-described using 4 variables: gradient, elevation (or stream width), temperature, and % pool. Since then, these relationships were shown to hold true throughout the nation (east, west and Midwest). These four variables, in combination, frequently describe 75-90% of the variation in fish abundances by species and size class. In addition, it is well known that the high annual variation in anadromous fish abundances makes them difficult populations to monitor and identify cause and effect relationships (for ex. see NAJFM paper about 1999?). Given this information, it is possible that the habitat trend monitoring and the fish population trend monitoring may have too much annual, site, and measurement variability to have long term confidence (particularly statistically significant).

In addition, many agencies in the NW have spent the last 2 decades describing fish habitat and abundances through various methods (such as Hankin and Reeves, R1/R4, and other variations). Although these methods are useful in cataloging conditions on the landscape, they provide little information on the reasons for inter-basin differences in fish production. For example, some basins may have high impacts from land management activities, yet they remain good fish producers (or vice versa).

In recent Biological Opinions, NOAA Fisheries identified a lack of studies on the effectiveness of classes of habitat actions, and the relationship of these to fish survival.

Considering these facts, I have a few concerns:

- 1) Are we spending too much effort, detail, and money on basin wide monitoring at the expense of smaller innovative studies that will give us better information and links to fish survival and production?
- 2) Considering that gradient, elevation, temperature and % pool habitat are likely capable of describing the majority of the variation in fish abundance, and these variables can be measured with remote sensing methods, can a reasonably inexpensive program be accomplished in numerous basins based on these predictors over time?
- 3) Are we putting the majority of effort and funding into monitoring programs that may yield little or no additional information about fish/habitat relationships than we have acquired over the last 35 years of fisheries science?
- 4) In this effort, are we ignoring site level and effectiveness monitoring studies that are based on hypothesis testing that may give meaning to the trend monitoring studies?

- 5) What is the fall-back strategy if this EMAP based basin habitat monitoring does not provide explanative relationships with fish production? Should we even expect it to?
- 6) The USFS has been implementing a similar program (PiBO) for several years. This program should have tested protocols, intensive field personnel training, and a QA/QC system. It seems that this effort should work cooperatively with them, with PiBO on federal lands and the BPA funded efforts concentrating on private lands using similar methodologies and site selection techniques (at least in the pilot basins). This would double the money and effort being spent. We did not hear much from the FS about their monitoring activities (past or present) in the upper Columbia, or evaluate their existing efforts and lessons learned.

-----Original Message-----

From: Karl M Polivka [mailto:kpolivka@fs.fed.us]

Sent: Sunday, January 16, 2005 5:21 PM

To: Bob Bugert

Cc: Richard Woodsmith

Subject: M&E workshop

Dear Bob:

I have a few comments to make that might be worth adding to the white paper outline you were preparing at the M&E workshop the other day. The discussion of sediment has been addressed recently in the literature. I was going to pipe up and say the following, but the discussion at the meeting took a different track and I never got my \$0.02 in. So here goes:

I think the question of how to measure sediment depends on what question is being asked -- i.e., are you measuring sediment to determine how spawning habitat has been affected or to determine how it might affect the food base that provides energy for growth and survival of juveniles. Mary Power's lab has a recent paper in Ecological Applications in which they constructed in-stream channels and artificially added sediment to achieve a wide range of embeddedness levels. They found that the invertebrate assemblage shifted from taxa that were vulnerable to fish (grazers, predators, etc.) to burrowing taxa such as oligochaetes, Dipteran larvae, etc. Burrowing made these species unavailable to foraging steelhead and fish growth rates were reduced 4-5 fold as embeddedness ranged from 0 to 100%. So the effects of sediment are complex and often require experimental work to determine what different levels of sedimentation might mean for fish performance. Other relevant questions might include how the flow regime in a particular system might interact with sediment -- i.e., how long to study reaches remain embedded? Do changes in flow flush sediment out of affected reaches on a temporal scale that might make the

effects of sedimentation less detrimental to fish? In other words, I'd advocate a more integrated approach to the measurement of the effects of sedimentation in affected reaches that would include determining whether shifts in the abundance of invertebrates linked to salmonids via trophic relationships have occurred. It just seems to be very difficult to come to conclusions about the performance of salmon based on individual measurements of particle size or embeddedness.

For reference, the article I referenced is:

Suttle, K. B., M. E. Power, J. M. Levine, and C. McNeely. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. *Ecological Applications* 14:969-974.

I hope this is helpful to the group -- please share as you feel is appropriate. Thanks for an interesting and informative meeting! I'll look forward to hearing everyone's progress in the future.

kp

Karl M. Polivka, Ph. D.  
Research Fishery Biologist  
Aquatic and Land Interactions Program  
Pacific Northwest Research Station, USDA Forest Service  
1133 N. Western Ave.  
Wenatchee WA 98801  
509-664-1736

From John Arterburn:

On another note One more thing that came up on the habitat protocols is how the canopy cover data is collected and used. Most protocols collect it from four points along a transect and get % for the reach but this data is collected at 6 locations and gives information on the center of the stream and the bank but not a value for the entire reach. Lots of possible combinations might be worth discussing at more length.

### *\*Monitoring and Evaluation Resource Links (not exhaustive)*

1. **The Pacific Northwest Aquatic Monitoring Partnership (PNAMP).** Jen Bayer (Coordinator), Bruce Crawford (Habitat), Keith Wolf and Jennifer O'Neal (Fish), Steve Lieder (Steering Committee), Steward Toshach (Data Management), Steve Lanigan (Watershed Conditions [habitat]). No pubic website available at this time.
2. **The Coordinated System Wide Monitoring and Evaluation Project (CSMEP).** Frank Young (CBFWA) and Dave Marmorek (ESSA).



- <http://www.cbfgwa.org/committees/csmep/default.cfm> &  
<https://nrimp.dfw.state.or.us/csmep/default.aspx>
3. **The Northwest Power and Conservation Council**-Dr. Steve Waste.  
<http://www.nwppc.org/>
  4. **The Wild Salmon Center/State of the Salmon Project.** [Xan Augerot, Ph.D.](#),  
<http://www.stateofthesalmon.org/>
  5. **The Bonneville Power Administration (RME/Fed. Caucus).** Jim Geiselman.  
<http://www.salmonrecovery.gov/federalcaucus.shtml>
  6. **The Northwest Fisheries Science Center.** Dr. Chris Jordan and Steve Katz.  
<http://www.nwfsc.noaa.gov/>
  7. **The Washington State Salmon Recovery Funding Board.** Bruce Crawford.  
<http://www.iac.wa.gov/>
  8. The Pacific Coastal Salmon Recovery Fund. <http://www.nwr.noaa.gov/pcsr/>
  9. **The Upper Columbia Regional Technical Team.** Bob Bugert
  10. **The Lower Columbia Fish Recovery Board.** Melody Tereski and Jeff Breckel  
<http://www.lcfrb.gen.wa.us/>
  11. **The Colville Tribes Fish and Wildlife Department.** John Arterburn.  
<http://www.colvilletribes.com>
  12. **KWA Ecological Sciences, Inc.** Paul Wagner and Keith Wolf.  
<http://www.kwaecoscience.com>
  13. **The U.S. Bureau of Reclamation.** Michael Newsom and Michael Beaty.  
<http://www.usbr.gov/>
  14. **BioAnalysts.** Tracy Hillman
  15. <http://www.xerces.org/aquatic/standard.htm>

*\*See workshop attendee attachment for email and telephone numbers.*